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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
DIVISION OF HEALTH ASSESSMENT AND CONSULTATION
PUBLIC HEALTH ADVISORY

NAVAJO-BROWN VANDERVER
AND
NAVAJO-DESIDERIO URANIUM MINING AREAS
NAVAJO NATIONS
BLUEWATER, NEW MEXICO

September 28, 1990

Statement of Purpose

This Public Health Advisory is issued to inform the Environmental Protection Agency (EPA), the Navajo Nations, the Indian Health Service (IHS), the Bureau of Indian Affairs (BIA), the State of New Mexico, and the public of a significant threat to human health near Bluewater, New Mexico. After evaluating available information and visiting the area, the Agency for Toxic Substances and Disease Registry (ATSDR) has determined that this Public Health Advisory is warranted for the Navajo-Brown Vanderver (N-BV) and Navajo-Desiderio (N-D) Uranium Mining Areas. The presence of uranium-containing radioactive mine wastes, areas potentially contaminated with heavy metals, and many physical hazards form the basis of this Advisory.

At the request of the EPA, Region VI and the Navajo Superfund Office (NSO), ATSDR initiated preliminary investigations of the radiological, chemical, and physical hazards associated with the N-BV and N-D uranium mines. These sites are not presently on the National Priorities List, but the NSO and the EPA are developing Preliminary Site Assessments.

A site visit was made to the Navajo-Brown Vanderver and Navajo-Desiderio Uranium Mining Areas. Field monitoring data were taken at the time of the visit. The ATSDR has concluded, based on the site visit, the data taken during that visit, and evaluation of other available information, that the presence of uranium-containing mine wastes, areas potentially contaminated with heavy metals, and many physical hazards are of public health concern. This finding has led to the issuance of a Public Health Advisory.

Background

The N-BV and N-D sites are in Bluewater, about 4 and 9 miles east of Prewitt, New Mexico, respectively. Both areas are in the Ambrosia Lake subdistrict of the Grants Uranium Mining District. Access to the areas is via improved dirt roads. These mining areas are in agricultural rural settings and adjacent to residential properties. Both mines are located on land owned by the Navajo Nations and held in trust by the Bureau of Indian Affairs. The present owner of the N-BV mine is Mr. Brown Vanderver, who lives at the site with his extended family. The owner of the N-D mine is Mrs. Jenny Desiderio, who inherited the mine from her deceased husband and lives on the site with her extended family.

The NSO estimates that at each site there are approximately 65 people, 30 of whom are children. Less than 3 miles from the sites is a preschool with a student enrollment of about 30 children. About 500 persons are potentially affected by these sites.

A potable municipal-type water supply system for the area is derived from a well installed by the IHS. The estimated depth of the well is about 1,100 feet. However, not all residents are on this water system. The wells used by those residences not on the public supply are shallow well systems operated by windmills.

The N-BV area encompasses about 155 acres, and the N-D mine covers about 130 acres. Both sites initially were open-pit mining operations. Besides the open-pit operations, the N-BV area includes horizontal mine shafts and ventilation shafts, some of which are almost vertical. The local residents use some shafts as solid waste disposal pits.

Historically, the N-BV mine was operated periodically from 1952 to 1966 by various companies including Santa Fe Uranium, Federal Uranium Mesa Mining Company, and the Cibola Mining Company. During the operations of this mine, conventional mining techniques were used. The ore removed from the mine was believed to be sorted by hand and shipped to regional mills located in the Shiprock, New Mexico, or the Durango, Colorado, areas. In its draft Preliminary Assessment of the site, NSO documented that over 25,000 tons were removed from the mine. The ore processing produced about 49 tons of uranium oxide (U_3O_8) and over 37 tons of vanadium pentoxide (V_2O_5). Ores not meeting the screening criteria for uranium content were discarded at the mine site. These ores now line the roads leading to the Brown-Vanderver residential and mine areas.

From 1952 to 1957, the N-D mine was operated by "Sante Fe" (exact name unknown, may not be the same company as previously mentioned) and the Hanosh Mines from Grants, New Mexico. The mining technique involved removing the soil overburden with heavy equipment followed by drilling and blasting the ores loose. The ores then were trucked to area mills for processing. Ores not meeting the minimum requirements for uranium content were disposed of at on-site locations. The NSO estimates that the 11,110 tons of ore removed by this operation contained over 83,000 pounds of U_3O_8 and over 17,500 pounds of V_2O_5.

At both the N-BV and the N-D mines, the physical hazards are of particular concern because of the number of children known to reside in the area. These physical hazards include both open mine shafts and open pits. Because of the depth of the shafts and the unrestricted access, an inadvertent intruder either entering or falling into the shafts could be difficult to find and rescue.

Explanation of Terms

This document contains terms associated with radioactivity and exposure dose as the result of radiation exposure, which may be unfamiliar or misinterpreted by the public. The terminology used in this Public Health Advisory is defined here.

A roentgen (R) is the unit of radiation exposure for gamma radiation or X-rays and generally defines the amount of energy transferred from the radiation to the air. An exposure of one R is equivalent to the energy deposition of 87.7 rads per gram of air. For gamma radiation, a rad is approximately equal to a rem. Nationwide, the natural background exposure is nearly 300 millirems per year, including exposure to radon.

A rem (roentgen equivalent man) is a unit of dose equivalence, whereas a roentgen is the unit of exposure to ionizing radiation. The rem equalizes the various types of radiation. The rem is a function of the radiation absorbed dose (the rad) and the quality of radiation. A millirem is 1 one-thousandth (1/1,000) of a rem and a microrem is 1 one-millionth (1/1,000,000) of a rem. In terms of radiation type, gamma rays are the least damaging internally and alpha particles (helium nucleus) are the most harmful upon exposure in the body.

The unit of radioactivity is the curie, equal to the amount of radioactivity present in one gram of radium. A picocurie (pCi) is equal to a trillionth of a curie (1×10^{-12}). Exposure levels of the radioactive gas, radon is commonly expressed as pCi per liter (pCi/L).

Basis for Advisory

During the week of July 24-27, 1990, personnel from ATSDR Headquarters and Region VI offices toured these sites. Accompanying the ATSDR personnel were representatives of the local Navajo chapter and NSO. During the visit, radiation readings were collected by both ATSDR and the NSO. Discussions also were held with officials and members of the Navajo Nations concerning life-styles, populations, health concerns, and land use in these areas.

Along the roadbed leading to the N-BV site, the area was littered with rocks and ore tailings. Within these materials, the uranium ores (yellowish material) were clearly visible. Environmental radiation readings along the road, obtained with a calibrated Ludlum Model 19 gamma radiation detector equipped with an NaI(Tl) scintillator, ranged from approximately 50 microroentgens per hour (uR/h) to over 500 uR/h, whereas the background radiation reading was 6 uR/h. Evidence also suggested that radioactive material had migrated off-site because of both wind-borne distribution and surface runoff during seasonal rains.

At the main mine shaft located in the pit-mined area, ore tailings were randomly piled around the site and radiation readings were elevated above background. A horizontal shaft entering the mountain was observed; and during discussions with local residents, it was mentioned that the shaft branches into three sections. Entrance to this mine shaft in not restricted. Vertical ventilation shafts were also observed; one shaft was about 10 degrees from vertical. A small shack was constructed over this ventilation shaft however, access to the shaft was not effectively restricted. Located near the residential areas were open adits (shafts) being used as solid waste disposal areas by the local residents. These adits may run at least 300 feet in length or depth. The residential areas are less than 200 feet from several adits, and access to these adits is also unrestricted.

Although air sampling data are lacking, because of the uranium content of these mines, the shafts provide an excellent path for the release of radon, a naturally occurring by-product of uranium decay.

During mining operations, analysis of the ores indicated the presence of heavy metals. These included vanadium, arsenic, barium, chromium, magnesium, manganese, strontium, titanium, and zirconium. Leaching may have occurred from these ores; however, no analyses of environmental samples are available to verify the presence of these contaminants. Although recent sampling information is lacking, the potential exists for humans to be exposed to these contaminants through ingestion or inhalation.

The Navajo-Desiderio mine is a series of open-pit areas of approximately 30 to 50 feet in depth and of varying lengths. The radiation readings at this site were about 50 uR/h. No restricted access to the pits was observed during the site visit; children play and livestock graze freely in the area, and residential areas are within 100 yards of the pits.

Through a Navajo interpreter, the owner of the mine, Jenny Desiderio, informed us that her grandson fell into one of the pits during a sledding accident. The child, who reportedly suffered brain damage, died a few years after the accident. According to Mrs. Desiderio, at least 18 livestock died after ingesting contaminated rainwater that reportedly collects in the pits. Whether the dead animals were examined by a veterinarian is not known. However, the NSO officials believe the animals may have died after ingesting heavy metals that leached from the ores into the pit areas.

Of the verified contaminants in these areas, those of concern are uranium and a member of its decay series, radon. Of the naturally occurring isotopes of uranium, uranium-238 (U-238) is the most abundant, present at concentrations greater than 99 percent. The primary mode of decay is via two alpha particles, each with a decay energy of approximately 4.2 million electron volts (MeV). The decay chain of which U-238 is the parent results in the production of both radium-226 and radon-222 and ultimately terminates with stable lead-206. During this decay series, beta particles and gamma rays are produced as well as additional alpha particles, all at different decay energies (1). Because uranium is ubiquitous in nature, the daily human dietary intake is approximately 1.9 micrograms. Therefore, the body normally contains an estimated 90 micrograms of uranium. This corresponds to a body burden of about 30 picocuries. Of this amount, about 66 percent is associated with the skeleton; the remainder is in the soft tissues. The biological half-life is 100 days for whole body and 15 days for the kidneys (2).

After ingestion, the fractional uptake of uranium into the blood is 0.05 for water-soluble inorganic forms and 0.002 for water-insoluble forms (1). The critical organs for ingestion are the skeleton and kidneys. The lung surfaces are the critical organ after inhalation, although there is some solubilization of deposited uranium followed by absorption or ingestion (2).

Because Rn-222 is an inert gas, most of the inhaled gas is exhaled, with only that which decayed potentially remaining within the lungs. These radioactive materials deposited within the lung expose the bronchial epithelium lining the respiratory system, resulting in an elevated risk of lung cancer (3,4). Exposure to radon and radon progeny has been directly correlated with the appearance of lung cancer in humans. The first epidemiological studies of radon exposure were conducted in 1879 in Europe. Since then, such studies have been conducted worldwide and many are still in progress. The studies involve uranium miners and show increasing risks of lung carcinomas as accumulated exposure to these products increased (4).

Rn-222 decays by emitting an alpha particle with an energy of approximately 5.5 MeV and gamma rays with an energy of 0.51 MeV. The half-life of Rn-222 is 3.8 days (1). The decay products are also radioactive, emitting mostly beta particles and gamma rays with an alpha particle released during one decay step. These radon progeny, with half-lives ranging from seconds to over 20 years, ultimately decay to a stable (nonradioactive) form of lead.

The implications of radon exposure are difficult to evaluate. Radon is inert and therefore does not attach to surfaces. However, the decay progeny are charged particles and can electrostatically attach to surfaces. Most progeny immediately attach to aerosols. The ratio of attached progeny to unattached progeny is important in dose calculations for as the ratio increases, the radiation dose to lung surfaces increases. Other factors affecting the lung dose include the ratio of Rn-222 to its progeny, the breathing patterns, lung characteristics, sex, and age of the individual exposed. In a recent report from the National Research Council (NRC), the dose from the radon progeny was of greater risk than exposure to radon gas (4). Dose estimates have been published by the National Council on Radiation Protection and Measurements, the NCRP (3). The NCRP estimates that the risk of developing lung cancer following a lifetime exposure to Rn-222 is 2.1×10^{-3} per pCi/L exposure under environmental conditions. The NCRP also states that the dose to the bronchial regions of a typical working adult because of exposure to Rn-222 is 0.27 rad per year per pCi/L. For a 10-year old child (12 hours active, 12 hours resting), the dose estimate is 0.45 rad/year per pCi/L.

Estimates of Radiation Exposure to Local Residents

Because detailed environmental monitoring for heavy metals and radioactive materials has not been performed, it is difficult to determine the health risks due to internal uptake of these materials. However, the external exposure to ionizing radiation can be evaluated using the on-scene monitoring results obtained by ATSDR and NSO.

The Brown-Vanderver mine site is in a residential area. In estimating the annual exposure to external ionizing radiation because of the contaminants in the area, ATSDR used the following assumptions for a maximally exposed individual (MEI). The MEI would live on the site for 100 percent of the time (24 hours) and 365 days per year. The average exposure, including background in the area, is estimated conservatively to be approximately 125 uR/h. Assuming these values and the 24-hour exposure, the external radiation at this site could result in an individual receiving an external annual exposure of nearly 1 R, about 3 percent of which is from natural background.

The risks of exposure to radiation have been investigated for nearly 100 years and the values have been peer reviewed and accepted by the scientific community. In terms of risk estimates, the NCRP, in 1987, used a risk value for excess cancers of 1×10^{-4} per rem per year for whole body exposure (5). The BEIR V report (6), released in 1990 by the NRC, places the risk of excess cancer mortality as a result of lifetime exposure at 5.2×10^{-3} for males and 6×10^{-3} for females (Table 4-2, BEIR V report). Using the estimated population of this area, this would translate to approximately three excess cancer deaths for residents in this area as a result of exposure to the radiation in this area.

Furthermore, because of the inherent production of radon released from the uranium-containing ores, the internal radiation dose, especially to the bronchial epithelium of the lungs, could be even higher. In a 1988 report, the NRC stated that the estimated dose to these tissues far exceeds any dose to organs from external natural background radiation (4). However, since no specific radon measurements have been made in this area, estimates of potential internal exposure to radon cannot be evaluated.

Conclusions

The Agency for Toxic Substances and Disease Registry concludes that the Navajo-Brown Vanderver and the Najavo-Desiderio Uranium Mining Areas pose a significant threat to human health for residents of these areas based on these premises:

1. The predictions of the external exposure model using the estimated exposures greatly exceed the recommendations of the NCRP.

2. The death of livestock that consumed standing water believed to be contaminated with heavy metals, especially if the carcasses are processed for either feed or human consumption poses a hazard to human health.

3. The many open mine areas, mine shafts, and the unrestricted access to these areas create a safety hazard.

4. Since evidence suggests that radioactive contaminants are migrating off-site and that heavy metals may be associated with the radioactive material, the local food and livestock crops could be contaminated. This could result in a significant internal exposure to both radioactive materials and heavy metals if these crops are ingested.

5. It is apparent that not all local residents are supplied with public water. Because of the runoff and surface contamination around these sites, the water quality of the individual wells may be suspect and hazardous to human chronically exposed to radioactive materials and heavy metals.

RECOMMENDATIONS

The ATSDR proposes the following recommendations to protect the public health of area residents:

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1. Dissociate local residents from the Brown-Vanderver mine site until radioactive contamination is removed.

2. Implement site restrictions to the open pits, mine shafts, and other mine access points.

3. Immediately sample public water supplies and private wells in the area for radioactive materials and heavy metals that may be present and exceed drinking water standards. Those wells exceeding standards should be capped and residents supplied with safe drinking water.

4. Ensure that the open pits are lined, filled, capped, and covered with clean fill. This would prevent the inadvertent intruder from falling into the pits, preventing injury and possibly death.

5. During any removal actions, implement dust control and site access restrictions.

6. Sample biota and air particulates and monitor radon to ascertain the potential for internal radiation exposure.

7. Because this is a chronic exposure, perform monitoring by lung counting or urinalysis of the local residents to determine uranium body burdens and the amount of internally deposited uranium.

8. ATSDR should obtain health care records for residents in these areas from either the IHS or BIA clinics and offices. These records could be used to establish a baseline health status of the local residents. Furthermore, these records might indicate if local residents were involved in earlier Public Health Service studies of uranium miners.

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